# Crystal Calibration at V.H.F.

By B. PRIESTLEY, G3JGO*

THE traditional method of producing 10 or 100 kc/s calibration pips at v.h.f. is to square up the fundamental frequency to produce sufficient harmonics and selectively amplify the desired frequency range. Since the lower harmonics are fundamentally stronger, it is difficult to avoid harmonics of noticeable strength appearing at the receiver tunable i.f. [1, 2]. The use of a tunnel diode pip generator [3] is a considerable improvement, giving harmonics of equal strength to well above 300 Mc/s in my experience, but still generating a whole string of harmonics. A system which only works at the desired frequency seems preferable and two possibilities were examined.

### Alternative System

If a carrier is modulated with a 100 kc/s square wave, sidebands at 100, 200, 300 kc/s are produced. If the carrier is accurately centred on 145 Mc/s then calibration pips can be produced over the 144-146 Mc/s band with a 100 kc/s signal which only contains appreciable harmonics up to the 10th. This system is quite practicable, using the simple modulator shown in Fig. 1, and is an ideal way of checking the sweep width of a wobbulator but suffers from the snag that the accuracy of the markers is dependent on the carrier frequency. However, the error in a crystal controlled oscillator at, say, 36 or 72 Mc/s may be no worse than the error in a 100 kc/s oscillator when multiplied by 1450 so the system is quite workable. The error in the 100 kc/s oscillator is only multiplied by a maximum of 10 and so should be quite negligible. The system, however, seemed a trifle cumbersome.

### The Method Chosen

If the modulation above is applied to an *oscillator* at the desired centre frequency, a remarkable thing happens when over-modulation occurs. The carrier and sidebands disappear, and are replaced by a series of harmonics of the modulation. Consequently there is no need for an accurate crystal and multiplier, a simple s.e.o. being adequate. My first experiments were done by feeding 100 kc/s into the 'phones socket of a valve grid dip oscillator. Encouraging results were obtained at 28 and 144 Mc/s, but rather more voltage swing was required for 100 per cent results than was available from the transistor oscillator in use [4].

The system shown was made up and found to work very well indeed. As a suitable *p-n-p* v.h.f. transistor was not available the system was tried out at 28 Mc/s with an OC170, but it will work equally well at 144 or 435 Mc/s provided the stability precautions described by G2HIF are observed.

### Practical Details

It is most important that the oscillator is stopped and started afresh by each cycle of the modulation. To ensure reliable starting and to check that the frequency is in the centre of the band, disconnect the oscillator from the modulator at point X, apply 4·5 volts and juggle the values of C1, C2 and R1 as necessary. Now reconnect the modulator and switch on. Make sure that the oscillator tuning only controls the strength and not the frequency of the pips. Also, beware of too high a value of C4, as this will keep the oscillator running through the off half cycle of the modulation. For once it is important to over-modulate!

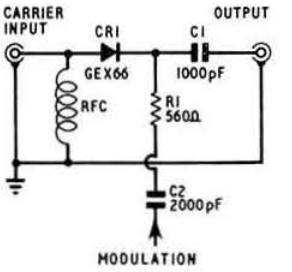


**Fig. 1. The simple modulator. RFC should be chosen to suit frequency.**

With the supply polarities changed the system would work equally well with *n-p-n* transistors, or with other forms of s.e.o. provided rapid starting and stopping is possible. A valve version is quite practicable, but less convenient.

### References

[1] "Obtaining Reliable 10 kc/s Frequency Markers in the Two Metre Band," G3LTF, RSGB BULLETIN, November 1964.

[2] "A Transistorised Band Edge and Centre Marker for Two Metres," P. K. Blair, J. R. Gazeley, BRS20533, RSGB BULLETIN, February 1961.

[3] "100 kc/s Crystal Marker for V.H.F," C. Sharpe, G2HIF, RSGB BULLETIN, July 1966.

[4] "A Transistorised Crystal Calibrator," B. Priestley, G3JGO, RSGB BULLETIN, June 1966.

*This article is published without full approval of the Society's Technical Committee.*

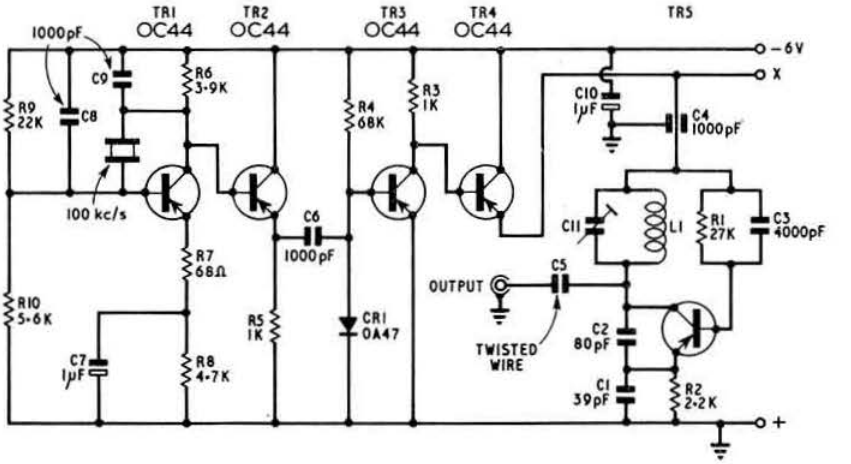


**Fig. 2. Self excited oscillator with a 100kc/s modulator. C1, C2, R1, L1 and VC1 will depend on the type of transistor used for TR5, which is selected according to the working frequency. In the prototype TR5 was an OC170, C11 was omitted and L1 was 8 turns of 20 s.w.g. wire ½ in. long on a ½ in. diam. former. This was for use at about 28·7 Mc/s.**

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By B. PRIESTLEY, BSc., G3JGO

*After the publication of my article in the June 1967 Bulletin I received some criticisms from the Technical Committee. The following note is an attempt to remove the Committee's objections.*

THE self excited oscillator is modulated with a rectangular waveform derived from the crystal source. The term " overmodulation " was meant to indicate the complete stoppage of oscillation before the end of the off half cycle, and was deliberately used to emphasise the need for sufficient 100 kc/s drive to reach this condition, which is similar to the effect of too much modulation power on an A3 transmitter. See Fig. 1.

This was simply a way of explaining how to get the circuit to work in practice; a detailed analysis of the circuit proceeds on different lines:

The output consists of a pulse or burst of oscillations at, say, 29·07 Mc/s, which repeats exactly every 10 $\mu$ seconds (the period of the 100 kc/s oscillation). It can be shown that such a waveform contains harmonics of 100 kc/s only. Also it seems reasonable that these harmonics are of maximum amplitude near 29·07 Mc/s. By a laborious Fourier analysis these results can be proved, but the results are hardly worth the effort.

However, Fourier analysis does demonstrate that with the s.e.o. accurately tuned to one particular harmonic and with the longest possible ON to OFF ratio, this particular harmonic may be produced up to 40dB stronger than are others. This seems an attractive way of using otherwise useless crystals for the v.h.f. bands, say the 17th harmonic of 8·5 Mc/s. Enterprising amateurs would do well to read Hahnel's article " Multichannel crystal control of V.H.F. and U.H.F. Oscillators " in *Proc. IRE* Jan. 1953 p. 79.

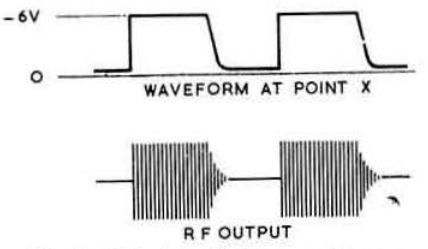


**Fig. 1. Hahnel oscillator waveforms.**

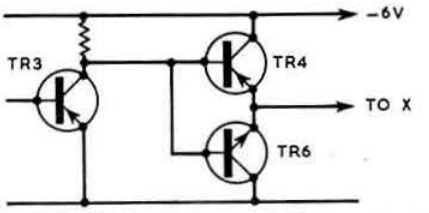


**Fig. 2. A modification for higher crystal frequencies. TR6 can be a 2N1302, 2N1304, 2N1306, 2N1308, OC139, OC140 or OC141.**

Experiments have shown that the charge stored in C4 is sufficient to keep the oscillator running through the off period if 500 kc/s markers are required, but the addition of a complementary transistor to the emitter follower discharges this rapidly and gives reliable results at the higher frequency. See Fig. 2.

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## *Scottish Mobile Rally and Region 14 ORM*

Although reasonably far north and effectively nearer winter than the rest of the United Kingdom, the decision to hold the combined Scottish Mobile Rally and Region 14 ORM late in September paid off reasonably well with a midsummer's day on the Saturday and a warm but very wet day on the Sunday, The total turnout for the two days' event was just under the 2000 mark, and this resulted in the National Trust for Scotland benefiting by nearly £300 which will go towards the Culzean Castle Restoration Fund.

The ORM which took place on the Saturday afternoon had Mr J. C. Graham, G3TR, Executive Vice-President of the RSGB and Mr J. F. Shepherd, GM3EGW, Zone G Representative, as official guests from the Radio Society of Great Britain.

During the ORM the ladies were treated to a beauty demonstration by consultants for the Beauty Council of Great Britain, and the children enjoyed themselves at a film show in the castle.

Much interest was shown by young and old in the great assortment of radio equipment which was on show at the Trade Exhibition, and in particular the Special Exhibition Prize—the new ten metre beam aerial, the " Miniten," which was presented by Minitenna Products for this special occasion. The Mobile Rally prizes went to Tom Hughes, GM3EDZ, who was judged to have the best mobile installation, and to Sam Nutt, G3OCR, who was the farthest travelled " mobileer "—all the way from Brighton. A further fifty prizes donated by the various manufacturers were distributed during the course of a social evening on the Saturday.

The Exhibition Station, GB3CC, which was run by the Lowland Royal Signals Amateur Radio Club, found itself in very much demand especially by the W's and K's when they realized that Culzean Castle was " Ike " Eisenhower's Scottish home.

Although there were several last minute cancellations by groups who had intended exhibiting and displaying at sideshows the abundance of natural facilities together with the organized ones, more than ensured a reasonably exciting and enjoyable time for all who attended, and it is to be hoped that this new event in the Amateur calendar will go from strength to strength and prove to be just as popular in the years to come.

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## CE1HL

Michael Humphries, G3LRQ, of Maldon, Essex, recently had a surprise visit from Jorge Navarro, CE1HL, of Chuquicamata, Chile, while Jorge and his wife were staying with their daughter and brother-in-law, who live in Maldon.

Jorge, who has now returned to Chile, is hoping to make contact with amateurs in the Maldon area on 20m s.s.b.